Industrial Assembly Cases

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Abstract

This technical report presents 13 different industrial assembly tasks, which are composed of 70 different operations. The report is written to provide an overview and do as such not contain product specific information such as object weights, dimensions etc. The operations are classified into a set of broad categories such as put/place, screw, mount etc., which in the end is counted to provide an overview of their frequency.

Contents

Introduction

This technical report presents a collection of industrial assembly tasks. Today all tasks are either performed manually or semi automatically with parts being manually placed in fixtures and fed into a machine making the actual assembly. A common characteristic is that the total production volumes of the parts are insufficient for a dedicated automated solution to be economically feasible, but still large enough that the companies wish to automate it to save costs.

Each assembly task in this report is presented by a short description of the task, images of the parts and a description of the steps in the assembly process. In the process description the wording is selected such that:

Put/Place refers to when the operation can be performed without a complicated sequence of motions. This includes straight forward peg-in-hole operations and placing parts into fixtures.

Mount is used when the operation requires a more complex motion often relying on a particular force and/or sequence of motions. Examples could be snap assemblies and combine push and turn motions.

Screw refers to operations in which the parts have threads, which needs to catch each other before being screwed in.

Press is used for operations where a certain amount of force is required to actually press object together (typically after these are placed on top of each other). When using press to define an operation it is assumed that the pressing can occur without a dedicated press - even though such may be used as part of the manual process.

Activate refers to operations activating external equipment which e.g. presses parts together or in other ways performs part of the assembly process.

The list above captures the main categories of operations, but is not complete. Additional operations such as adjust and test also occur, but in too low numbers for a general category.

Notice that the cases described does not include how objects are fed into the system and where to palce objects after the assembly.

Cases

Case: Pipe connection

Description

Assembly of pipe connection by mounting union nuts on pipe and bending pipe ends

Parts

Part No.	Description	
1	Tube	
2	Union nuts	
3	Final assembled part	

Process

1. Put end of pipe (Part 1) into machine for creating a collar.
2. Activate the machine bending the collar.
3. Put two union nuts (Part 2) onto pipe.
4. Put other end of pipe (Part 1) into machine for creating a collar.
5. Activate the machine bending the collar

Notes

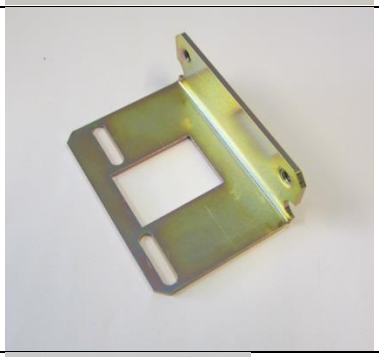
The two union nuts need to be placed opposite, such that the indent is facing towards the collar.

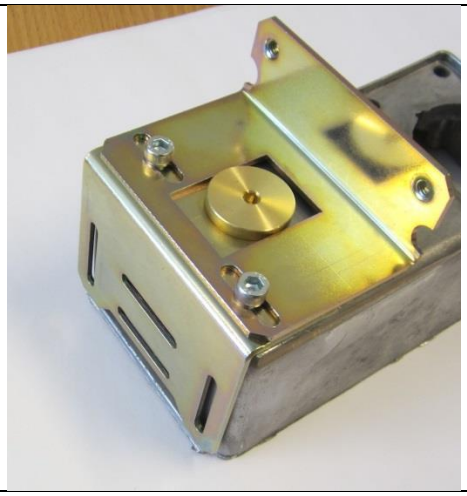
Case: Bracket for wall mounting water mixer Part 1

Description

Assembly of subcomponent for bracket for wall mounting water mixer.

Parts

Part No.	Description	
1	Lock washer	
2	Angle bracket 1	
3	Disc	
4	Angle bracket 2	
5	2x bolt	

	Final subassembly	

Process

1. Place lock washer (Part 1) on fixture.
2. Place angle bracket 1 (Part 2) on fixture on top of lock washer.
3. Place metal disc (Part 3) on fixture. The small tab of the disc needs to align with the hole in the lock washer.
4. Press on the disc to make it lock into the lock washer.
5. Place angel bracket 2 (Part 4) on fixture.
6. 2x screw in bolt (Part 5) to join angle bracket 1 and angle bracket 2.

Notes

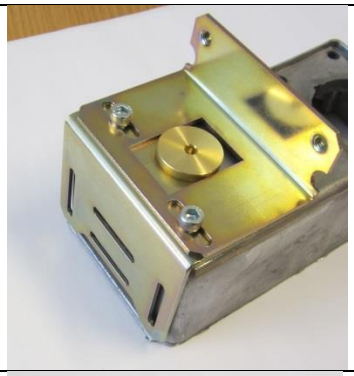
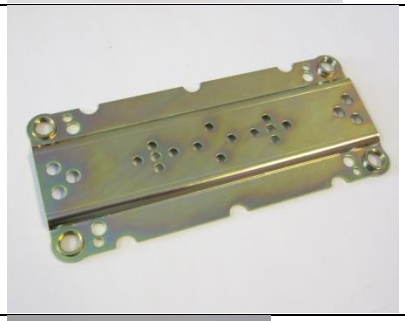
In the manual operation the pressing in step 4 is done by exercising an impulse with a hammer.

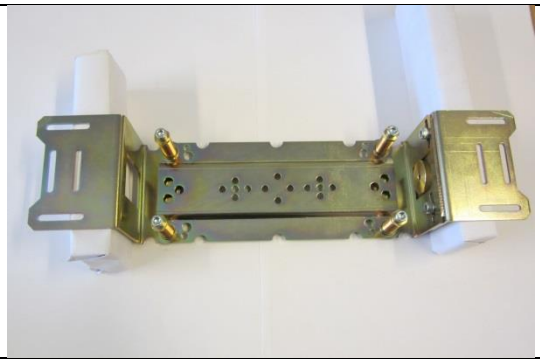
Case: Bracket for wall mounting water mixer Part 2

Description

Assembly of end brackets with base plate for wall mounting of water mixture.

Parts

Part No.	Description	
1	Subassembly from Part 1	
2	Angle bracket	
3	Base plate	
4	Hollow bolt	
5	Bolt	

	Assembled part	

Process

1. Place subcomponent (Part 1) in fixture.
2. Place angle bracket (Part 2) in fixture.
3. Place base plate (Part 3) on top of Part 1+2 in fixture.
4. 4 x screw hollow bolts (Part 4) into base plate.
5. 4 x put bolts (Part 5) into hollow bolts and screw them in connecting base plate (Part 3) with brackets (Part 1+2).

Notes

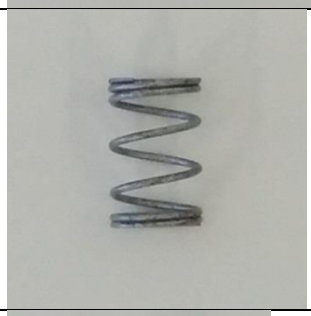
The base plate (Part 3) exists in a number of different lengths. All other components are the same.

Case: 5 Part Subassembly

Description

Assembly of subcomponent comprised of housing, locking collar, spring, plastic part and screw.

Parts

Part No.	Description	
1	Housing	
2	Locking collar	
3	Spring	
4	Plastic part	
5	Screw	

Process

1. Put locking collar (Part 2) on fixture.

2. Place housing (Part 1) on top of fixture with tabs inside locking collar.
3. Place spring (Part 3) inside housing (Part 1).
4. Put plastic part (Part 4) into housing (Part 1).
5. Press parts together.
6. Screw screw (Part 5) in locking collar (Part 2)

Notes

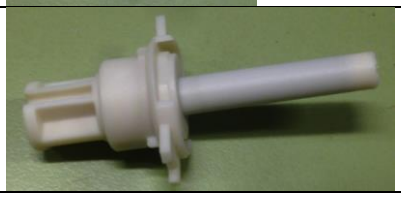
An external press is used to press the parts together, but it could potentially be done in another way.

Case: Spindle Type 1

Description

Assembly of spindle type 1.

Parts

Part No.	Description	
1	Spring	
2	Housing for spring	
3	Screw for spindle	
4	Nut for spindle	
5	Assembled part	

Process

1. Put housing (Part 2) on nut (Part 4) .
2. Place spring (Part 1) in housing (Part 2).
3. Screw screw (Part 3) into nut (Part 4).

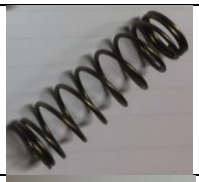
Notes

Case: Spindle Type 2

Description

Assembly of spindle type 2.

Parts

Part No.	Description	
1	Spring	
2	Actuator housing	
3	Spring housing	
4	Screw	
5	Assembled part	

Process

1. Screw screw (Part 4) in spring housing (Part 3).
2. Place spring (Part 1) in spring housing (Part 3).
3. Press actuator housing (Part 2) onto spring housing (Part 3).

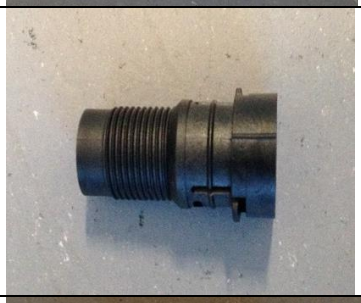
Notes

Case: Handle

Description

Mount insert into handle.

Parts

Part No.	Description	
1	Handle	
2	Insert	
3	Assembled Part	

Process

1. Place insert (Part 2) into handle (Part 1).
2. Press parts together.

Notes

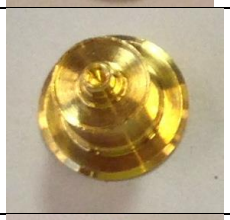
The pressing of parts together is currently done with a dedicated press, but could potentially be done by other means.

Case: Regulator

Description

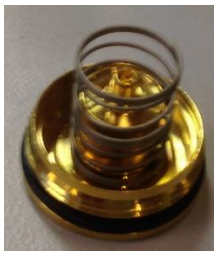
Assembly of regulator.

Parts

Part No.	Description	
1	Spring	
2	O-ring	
3	Cone	
4	Seat – bottom	
5	Seat – top	
6	Washer	
7	Membrane	

Process

1. Mount o-ring (Part 2) around seat – bottom (Part 4).
2. Place cone (Part 3) on seat – bottom (Part 4).
3. Place spring (Part 1) on cone (Part 3) .



4. Place seat – top (Part 5) onto subassembly from step 3.
5. Mount membrane (Part 7) on subassembly from step 4.
6. Mount washer (Part 6) on subassembly from step 5.
7. Press parts together.

Notes

The diameter of the finished component is around 19mm.

Case: Assembly of Valve

Description

Mounting of regulator, insert and top on valve housing.

Parts

Part No.	Description	
1	Regulator	
2	Insert	
3	Valve housing	
4	Valve top	

Process

1. Screw regulator (Part 1) into valve housing (Part 3).
2. Test regulator by mounting on external equipment.
3. Put insert (Part 2) into valve top (Part 4).
4. Screw subassembly from step 3 onto valve housing (Part 3).
5. Adjust the green part of the valve top (Part 4) to a zero position.

Notes

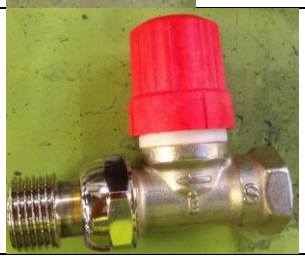
Pressing the plastic cap onto the valve is currently done by exercising an impulse, rather than a continuous pressure.

Case: Final mounting of valve

Description

Mounting of nipple and plastic cap.

Parts

Part No.	Description	
1	Valve	
2	Nipple	
3	Plastic cap	
4	Assembled part	

Process

1. Screw nipple (Part 2) on valve (Part 1).
2. Put plastic cap (Part 3) on valve (Part 1).
3. Press plastic cap (Part 3) onto valve on final assembled part (Part 4).

Notes

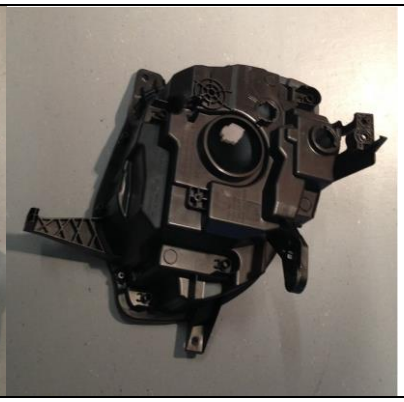
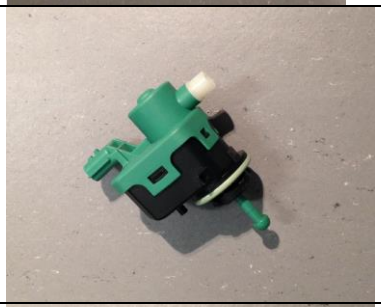
Pressing the plastic cap onto the valve is currently done by exercising an impulse, rather than a continuous pressure.

Case: Front Light for Car 1

Description

Mounting of parts for a front light for a car.

Parts

Part No.	Description	
1	Plastic base for front light (Left top view, right bottom view)	 
2	Screw	
3	Heat sink	
4	Plastic part 1	
5	Plastic part 2	

6	Assembled part (Left top view, right bottom view)	

Process

1. Screw in screw (Part 2) on base top side (Part 1, left).
2. Mount heat sink (Part 3) on base top side (Part 1, left).
3. Mount (snap assembly) plastic part 1 (Part 4) on base bottom side (Part 1, right).
4. Mount (snap assembly) plastic part 2 (Part 5) on base bottom side (Part 1, right).

Notes

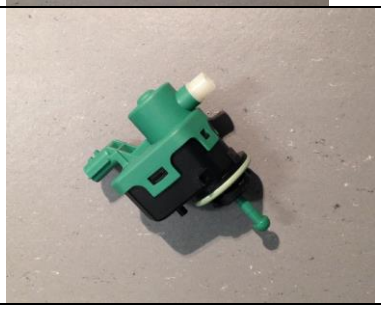
The mounting of plastic parts (Part 4+5) requires that parts are correctly aligned, inserted into the hole and turned until it snaps into place.

Case: Front Light for Car 2

Description

Mounting of parts for a front light for a car.

Parts

Part No.	Description	
1	Plastic base for front light	
2	Screw	
3	Plastic part	

Process

1. Screw in screw (Part 2) on top side of plastic base (Part 1)
2. Mount (snap assembly) plastic part (Part 3) on bottom side of plastic base (Part 1)

Notes

The mounting is similar to case “Front Light for Car 1”, but with less parts and a different geometry of the plastic base (Part 1).

Case: Rotor assembly

Description

Assembly of rotor for submersible pump.

Parts

Part No.	Description	
1	Pressure ring	
2	Rotor shaft	
3	8 Magnets	
5	Rotor cap	
	Assembled part	

Process

1. Mount pressure ring (Part 1) on rotor shaft (Part 2).
2. Place subassembly of step 1 into fixture.
3. Place the 8 magnets (Part 3) around the robot shaft (Part 2) in the fixture.
4. Mount rotor cap (Part 5) on robot shaft (Part 2) with the shaft going through the hole of the cap.
5. Activate press.

Notes

Pressing the parts together is done by a hydraulic press and requires a significant force.

Summary of Operations

The table below summarizes the number of occurrences of the different types of processes. The counting is done such that if one assembly needs to have e.g. inserted two screws this count as two operations even though these are written in a single line in the process descriptions above.

Operation	Number of occurrences	Percentage
Put/Place	32	46%
Mount	9	13%
Screw	18	26%
Press	6	9%
Activate	3	4%
Other	2	3%
Total	70	100%

The by far most frequent is the *Put/Place*, which corresponds to a relative simple operation, which given full knowledge of parts can easily be solved using conventional programming. The *Mount* operations require more complex behavior often relying on a particular force and sequence of motions. The *Screw* category represents both cases with conventional screws/bolts/nuts as well as cases where general parts (e.g. Part 1 in "Case: Valve mounting") have threading that need to be screwed together. The *Press* operations describe those cases where it would be realistic that e.g. a robot presses the parts together without using additional machinery. Finally the *Activate* operations represent those where external equipment needs to be activated as part of the assembly process. The *Other* category represents all not fitting the above mentioned and includes operations such as running tests and adjustments.

Conclusion

This technical report describes a total of 13 different assembly task composed of 70 operations. The report is written to provide an overview of the actual assembly operations and is not including information about how object are fed in and out of the process. This omitting of the feed in/out is done purposely as this alone has enough content for a complete technical report on its own.

Acknowledgement

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